Complications of Nonoperative Management of High-Grade Blunt Hepatic Injuries

Rosemary A. Kozar, MD, PhD, John B. Moore, MD, Sarah E. Niles, MD, John B. Holcomb, MD, Ernest E. Moore, MD, C. Clay Cothren, MD, Elizabeth Hartwell, MD, and Frederick A. Moore, MD

Background: **Nonoperative management of blunt hepatic injuries is highly successful. Complications associated with high-grade injuries, however, have not been well characterized. The purpose of the present study was therefore to define hepatic-related complications and associated treatment modalities in patients undergoing nonoperative management of high-grade blunt hepatic injuries.**

Methods: **Three hundred thirty-seven patients from two regional Level I trauma centers with grade 3 to 5 blunt hepatic injuries during a 40-month period were reviewed. Complications and treatment of hepatic-related complications in patients not requiring laparotomy in the first 24 hours were identified.**

Results: **Of 337 patients with a grade 3 to 5 injury, 230 (68%) were managed nonoperatively. There were 37 hepatic-related complications in 25 patients (11%); 63% (5 of 8) of patients with grade 5 injuries developed complications, 21% (19 of 92) of patients with grade 4 injuries, but only 1% (1 of 130) of patients with grade 3 injuries. Complications included bleeding in 13 patients managed by angioembolization (n = 12) and laparotomy (n = 1), liver abscesses in 2 patients managed with computed tomography-guided drainage (n = 2) and subsequent laparotomy (n = 1). In one patient with bleeding, hepatic necrosis followed surgical ligation of the right hepatic artery and required delayed hepatic lobectomy. Sixteen biliary complications were managed with endoscopic retrograde cholangiopancreatography and stenting (n = 7), drainage (n = 5), and laparoscopy (n = 4). Three patients had suspected abdominal sepsis and underwent a negative laparotomy, whereas an additional three patients underwent laparotomy for abdominal compartment syndrome.**

Conclusion: **Nonoperative management of high-grade liver injuries can be safely accomplished. Mortality is low; however, complications in grade 4 and 5 injuries should be anticipated and may require a combination of operative and nonoperative management strategies.**

Key Words: **Blunt hepatic injuries, Nonoperative management, Biloma, Angioembolization.**

J Trauma. 2005;59:1066–1071.

The practice of nonoperative management of blunt hepatic injuries in hemodynamically stable patients is clearly the standard of care. Numerous studies over the past two decades have confirmed both its feasibility and safety. Success rates for those patients selected for nonoperative management generally exceed 95%. Hepatic-related complication rates in most series are low, ranging from 0% to 7%.[1–5] As these studies have included patients with all grades of liver injury, the majority of patients sustained low-grade injuries. Pachter et al., in the Western Trauma Association Nonoperative Liver Study in 1995, reported only a 5% incidence of complications and a 0.4% incidence of hepatic-related deaths, with over 98% of patient avoiding operative intervention.[4] Complications in patients with high-grade hepatic injuries, however, may be significantly higher and their management more complex. Most studies examining complex injuries have combined patients with blunt and penetrating injuries and have included patients who have undergone initial operative intervention. For example, the Western Trauma Association's Multicenter Trial of 210 patients with complex hepatic injuries included both blunt and penetrating trauma and all patients underwent initial operative intervention.[6] They defined complex injuries as grades 3 to 5, which represented only 16% of all hepatic trauma. These patients had a high overall (46%) and liver-related (30%) mortality, as well as significant liver-related morbidity including prolonged biliary leak (8%), intra-abdominal abscess (9%), coagulopathy (16%), and late hemorrhage (7%). The Los Angeles County group has more recently reported on attempts to lessen mortality in these critically injured patients by combining operative strategies for control of bleeding with nonoperative strategies to manage hepatic complications in patients with both blunt and penetrating injuries.[7,8] Despite this multidisciplinary approach, their overall mortality for patients with grades 4 and 5 injuries was 9%. The majority of these

Submitted for publication June 22, 2005.
Accepted for publication August 15, 2005.

From the Departments of Surgery (R.A.K., S.E.N., F.A.M.) and Pathology (E.H.), University of Texas–Houston, Houston, the U.S. Army Institute of Surgical Research (J.B.H.), Fort Sam Houston, Texas, and Denver Health Medical Center, Denver, Colorado (J.B.M., E.E.M., C.C.).
Presented at the 35th Annual Meeting of the Western Trauma Association, February 27–March 5, 2005, Jackson Hole, Wyoming.
The opinion expressed (J.B.H.) here is the private view of the author and is not to be construed as official or reflecting the views of the United States Department of Defense. This is a United States government work and is not copyrighted.
Address for reprints: Rosemary A. Kozar, MD, PhD, University of Texas–Houston, 6431 Fannin, MS 4.284, Houston, TX 77030; email: rosemary.a kozar@uth.tmc.edu.
DOI: 10.1097/01.ta.0000188937.75879.ab

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 NOV 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Complications of nonoperative management of high-grade blunt hepatic injuries	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Kozar R. A., Moore J. B., Niles S. E., Holcomb J. B., Moore E. E., Cothren C. C., Hartwell E., Moore F. A.,	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX 78234	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT	b ABSTRACT	c THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**6**	

Table 1 Liver Injuries by Management, ISS, and Mortality

Grade	Total Injuries	Minus Operative Cases	Nonoperative Cases (Study Cohort) (%)	ISS	Overall Mortality (%)
3	178	–48	130 (73)	23 ± 1	5 (3.9)
4	128	–36	92 (72)	28 ± 1	4 (4.4)
5	31	–23	8 (32)	40 ± 4	1 (12.5)
Total	337	–107	230 (68)	24 ± 1	10 (4.3)

patients sustained penetrating injuries and all underwent operative therapy. As we have now successfully reduced hepatic-related mortality with nonoperative management strategies, the focus now should be on reducing hepatic-related morbidity to optimize patient outcome. Therefore, the purpose of the current study was to define hepatic-related morbidity in patients sustaining high-grade blunt hepatic injuries that were selected for nonoperative management.

PATIENTS AND METHODS

Over a 40-month period ending in May 2003, 337 adult (>13 years of age) patients with grades 3 to 5 blunt hepatic injuries were admitted to two busy regional Level I trauma centers. Of these patients, 107 underwent immediate surgical intervention and were excluded from further analysis. The remaining 230 patients did not require immediate laparotomy (defined as within the first 24 hours of injury) and form the basis for this analysis.

All charts were reviewed retrospectively and institutional review board approval was obtained. Demographic data collected included age, gender, mechanism of injury, and Injury Severity Score (ISS). The grade of hepatic injury was determined and based on computed tomographic (CT) findings according to the American Association for the Surgery of Trauma Organ Injury Scale for hepatic injuries.[9,10] For the current study, high-grade injuries were considered grades 3 to 5.[6]

Hepatic-related mortality was defined as deaths caused by ongoing liver bleeding or liver failure, or deaths related to complications of massive fluid resuscitation. Hepatic-related complications were defined as bleeding if intervention, either angioembolization or laparotomy, was required (the need for blood transfusion or simply having undergone a liver angiogram for suspected bleeding was not considered a complication); liver-related infection including a hepatic or perihepatic abscess or hepatic necrosis; biliary, including the development of a biloma (whether sterile or infected), bile peritonitis, or bile duct injury, requiring treatment (hyperbilirubinemia itself was not considered a complication); missed hollow viscus injury, actual or suspected if a laparotomy was performed; and development of abdominal compartment syndrome requiring decompressive laparotomy.

Treatment of hepatic-related complications was multidisciplinary when appropriate and included early angiography and angiographic embolization, endoscopic retrograde cholangiopancreatography (ERCP) and stenting of biliary leaks, and CT scan-guided drainage of hepatic or perihepatic abscesses or biliary collections by interventional radiology (IR). Surgical interventions included either laparotomy or laparoscopy. Data are presented as mean ± SEM.

RESULTS

Of 17,409 blunt trauma admissions, 1,037 patients presented with hepatic injuries, of which 337 (32%) were grade 3, 4, or 5 injuries. Table 1 provides a breakdown of these high-grade injuries. Two hundred thirty (68%) were initially managed nonoperatively and form the basis of the current study. Nonoperative management was pursued in roughly three-fourths of patients with grades 3 and 4 injuries, but in only about one third of patients with grade 5 injuries. One hundred twenty-seven (55%) of the study population were male patients, and the mean age was 31 years (range, 15–84 years). Blunt injury mechanisms included 188 motor vehicle crashes, 12 pedestrian accidents, 8 falls, and 22 other injuries. Overall ISS was 24 ± 1. Patients with grade 3 injuries had a mean ISS of 23 ± 1, patients with grade 4 injuries had a mean ISS of 28 ± 1, and patients with grade 5 injuries had a mean ISS of 40 ± 4. Overall mortality was 4.3% (10 of 230). Not surprisingly, patients with grade 5 injuries had an overall higher mortality. There was only one hepatic-

Table 2 Liver-Related Complications by Grade and Clinical Course of Interventions

1 Grade 3 injury patient
  BDL → ERCP/stent
19 Grade 4 injury patients
  7 Bleeds → IR
  1 Bleed → IR → sepsis → negative E-Lap
  2 peritonitis → laparoscopy → BDL → ERCP/stenting → biloma → IR
  1 Peritonitis → laparoscopy → BDL → ERCP/stenting
  1 Peritonitis → laparoscopy
  2 Biloma → IR → BDL → ERCP/stenting
  1 Biloma→ IR
  1 ACS → D-Lap
  1 Sepsis → negative E-Lap
  1 Abscess → IR → Failure → OR
  1 Abscess → IR
5 Grade 5 injury patients
  Bleeding → OR (SHAL) → necrosis → OR → MOF/death
  Bleeding → IR → Sepsis → negative E-Lap
  Bleeding → IR → ACS → D-Lap
  Bleeding → IR → ACS → D-Lap → BDL → ERCP/stenting
  Bleeding → IR

SHAL, selective hepatic artery ligation; OR, operation; MOF, multiple organ failure.

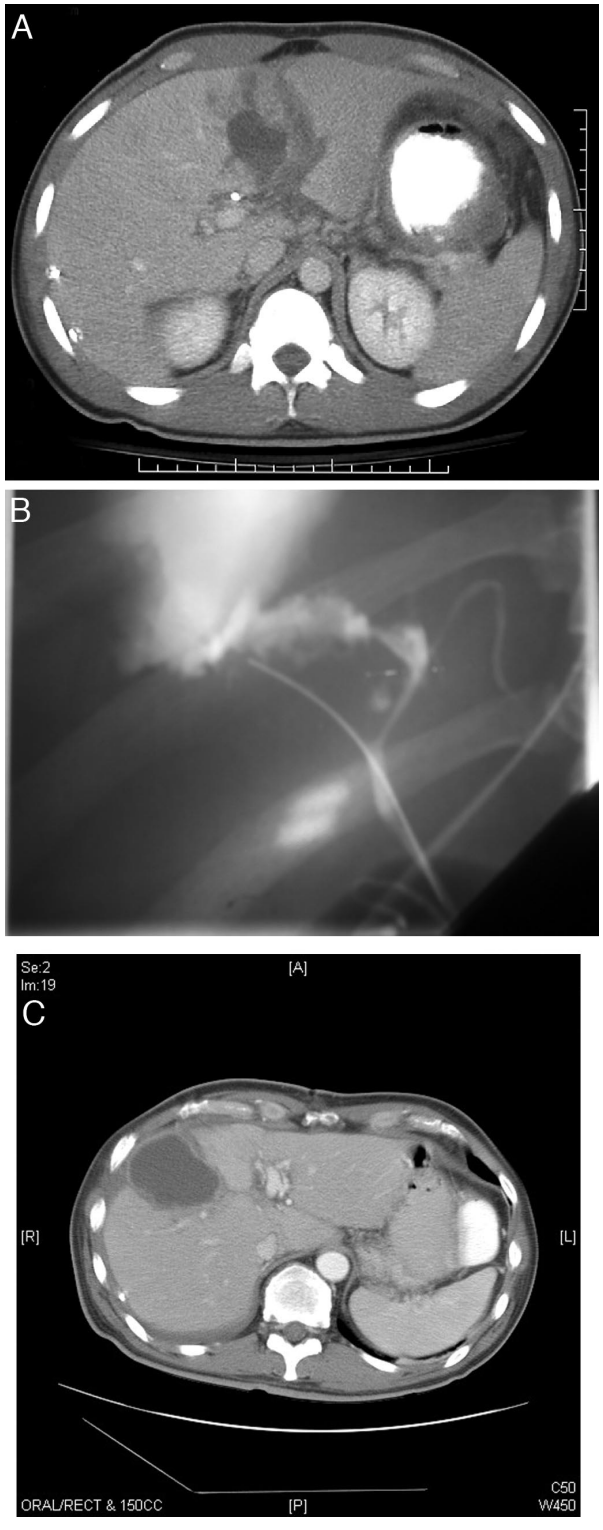

Fig. 1. *(A) Abdominal CT image of a patient with a grade 4 liver laceration at the junction of the right and left lobes. (B) ERCP of this patient 7 days after laparoscopy for bile peritonitis. ERCP reveals a large leak from either the medial or lateral segment of the left hepatic duct that was treated with stenting. (C) Two days later, the patient developed recurrent symptoms of right upper quadrant pain. Repeat abdominal CT scanning revealed a biloma that was successfully drained by interventional radiology.*

related death that was secondary to multiple organ failure in a patient with a grade 5 injury.

There were 37 hepatic-related complications in 25 patients, for an overall complication rate of 11% (25 of 230). Complications included 12 bleeding episodes, 16 biliary tract-related complications, three cases of abdominal compartment syndrome (ACS) requiring decompressive laparotomies (D-Lap), two liver abscesses, three negative exploratory laparotomies (E-Lap) performed for suspected abdominal sepsis, and one liver necrosis. There were 130 patients with a grade 3 injury, only one (<1%) of which developed one complication. Of ninety-two patients with a grade 4 injury, 19 (21%) developed 27 complications. Lastly, only eight patients had a grade 5 injury, five (63%) of which developed a total of nine complications. The breakdown of liver-related complications by grade and clinical course of interventions is depicted in Table 2. The only patient with a grade 3 injury with a complication was a peripheral bile duct leak (BDL) incidentally diagnosed on an ERCP that was being performed to rule out pancreatic injury and was treated by stenting. In contrast, 21% (19 of 92) patients with grade 4 injuries developed complications. Eight episodes of bleeding were successfully treated by IR embolization (7 on postinjury day [PID] 0 and 1 on PID 1). One of these patients went onto develop persistent unexplained sepsis that prompted a negative E-Lap on PID 6. There were four cases of bile peritonitis that were treated with laparoscopic washout and drainage (on PIDs 2, 5, 8, and 14). Three of these patients had bile leaks that prompted ERCP and stenting (on PIDs 5, 8, and 14) and then subsequent IR drainage of bilomas (on PIDs 9, 10, and 15). There were three additional bilomas diagnosed by CT scanning that were treated by IR drainage (on PIDs 3, 8, and 10); two had persistent bilious output that prompted ERCP and stenting (on PIDs 6 and 18). One patient developed ACS and underwent D-Lap on PID 3. Small bowel edema, but not significant hemoperitoneum, was found. One additional patient underwent a negative E-Lap for presumed missed hollow viscus injury on PID 1. Finally, two grade 4 injury patients developed an intraparenchymal abscess. Both were initially managed by IR drainage (on PID 29 and PID 90, respectively). One of these failed and the patient underwent subsequent laparotomy for definitive treatment.

Five (63%) patients with grade 5 injuries had early bleeding requiring intervention. One was taken directly to the operating room (on PID 1) and underwent right selective hepatic artery ligation. This was complicated by right hepatic lobe necrosis that was later resected (PID 4). This patient succumbed to unremitting multiple organ failure (on PID 9). The remaining four patients underwent angioembolization (one on PID 0, two on PID 1, and one on PID 8). One underwent negative E-Lap for fever, tachycardia, and possible small bowel injury seen on CT scan. Two patients developed ACS on the day of angioembolization (PID 1) treated by D-Lap (hemoperitoneum was the cause in both cases). One of these patients had persistent bilious drainage and underwent

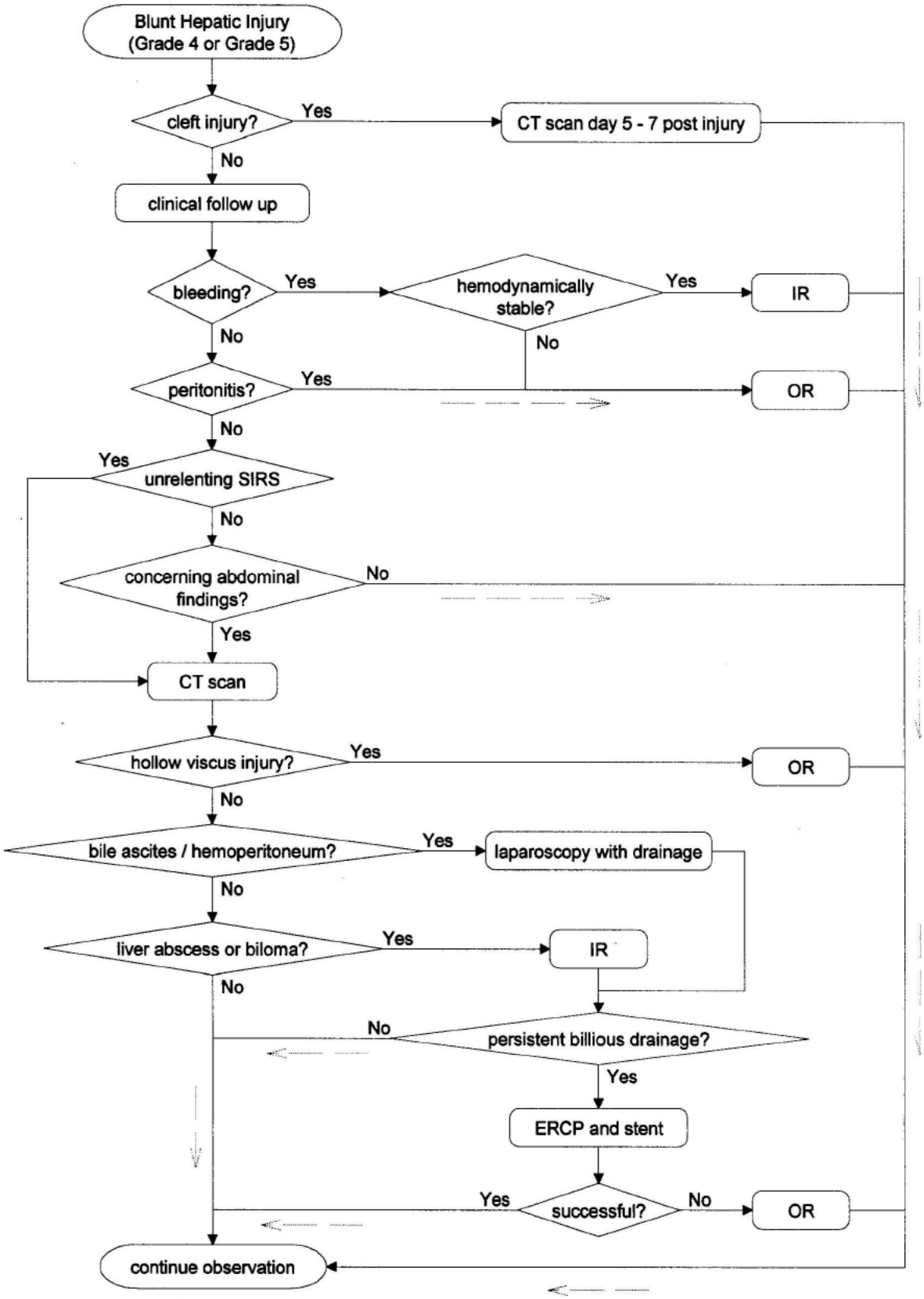

Fig. 2. *Multidisciplinary pathway for the management of grades 4 and 5 blunt hepatic injuries initially managed nonoperatively.*

delayed ERCP and stenting for a bile duct leak on PID 12. The last patient required only angioembolization.

Overall, 12 patients (5.2%) required operative intervention: one for hemorrhage, which later required a hepatic lobectomy for necrosis; three for suspected abdominal sepsis; one for definitive drainage of a hepatic abscess; three to decompress ACS; and four for biliary peritonitis by means of laparoscopy. Of note, four of the five patients with grade 5 injuries who developed complications required some type of operative intervention.

DISCUSSION

Since the late 1980s, there have been many studies documenting the safety and feasibility of nonoperative management for hepatic injuries. Recent series report that approximately half of all patients with liver injuries can be managed nonoperatively, with a success rate of up to 98.5%. Complication rates in general are low for these patients. Management of patients with high-grade injuries, however, may be more complex. The purpose of the current study was to better delineate hepatic-related complications and treatment modalities in patients with high-grade blunt hepatic injuries, defined as American Association for the Surgery of Trauma grades 3 through 5. Although our overall complication rate was only 11% (25 of 230 patients), 24 of 25 (96%) patients who developed complications had either a grade 4 or a grade 5 injury. Specifically, 21% of patients with a grade 4 injury and 63% of patients with a grade 5 injury developed a hepatic-related complication. This is in sharp contrast to the less than 1% incidence seen in patients with a grade 3 injury. This low incidence of complications with lower grade injuries has been corroborated by others as well.[11]

Significant bleeding occurred in 13 of our patients. Neither the simple requirement for transfusion nor need for angiography was considered a bleeding complication in this study. Angioembolization was used in all but one patient and was successful in 100% (12 of 12) of patients. Overall, 5.2% (12 of 230) patients underwent angioembolization, in contrast to 68% of patients reported by Asensio. This difference is likely because our patients, by definition of the study, were hemodynamically stable on presentation and therefore were not deemed candidates for immediate operation. One patient became hemodynamically unstable on PID 1 and required emergent laparotomy rather than angioembolization. This is in contrast to the study by Velmahos et al.,[12] who reported no failures of nonoperative management caused by delayed bleeding from the liver. Most episodes of bleeding in the current study occurred on the day of injury or within the first 2 PIDs, but one patient with a grade 5 injury required angioembolization on PID 8. Delayed hemorrhage has been reported after even longer periods of time and was attributed to delayed rupture of hepatic hematomas.[13] Angioembolization has become recognized as an important adjunct to management in patients with high-grade injuries, whether managed operatively or nonoperatively, or secondary to blunt or penetrating injury.[7,8] In fact, early angioembolization has been reported to lessen the need for blood transfusions and the number of liver-related operations[14,15] but has not improved outcomes in patients who required operative management.[16] In contrast, Richardson et al. have attributed the reduction in death rates over time, at least in part, to a decrease in major venous injuries requiring surgical intervention.[17]

Biliary tract complications (8 patients developed 16 complications) were as common as bleeding in the present study and included biliary leaks, bilomas, and bile peritonitis. Although similar rates have been reported by some authors,[18,19] others have reported significantly higher rates.[7,11] Most notably, Carrillo et al. reported in their study of nonoperative management of blunt liver injuries that of the 32 patients (of 135, all grades) who required some type of intervention, 10 had perihepatic collection drainage percutaneously, eight underwent ERCP and stenting, and 2 required laparoscopy for bile peritonitis.[11] As both studies suffer from retrospective design, there are inherent flaws in such a comparison. In addition, there is no well-defined definition of biliary complications, nor is there a well-accepted strategy for diagnosis. Lastly, the incidence of biliary complications is likely related to the degree to which they were sought.[20] When ERCP was performed in conjunction with CT scanning in patients with blunt liver injuries, Sugimoto et al.[21] reported a 21.4% incidence of bile duct injuries. In the current study, neither routine ERCP nor follow-up CT scanning was performed, as has been recommended by some.[22] This may have resulted in earlier diagnosis of complications. Patients with a major laceration through the porta hepatis may particularly benefit from early screening.[23] One of our patients with such an injury (Fig. 1 *A*) did indeed demonstrate a bile duct injury. By hospital day 5, the patient continued to display significant abdominal discomfort, persistent ileus, and hyperbilirubinemia accompanied by fever and tachycardia, prompting laparoscopy. Delayed laparoscopy for management of biliary peritonitis (peritoneal and systemic signs suggestive of systemic inflammatory response) has been advocated by Carrillo et al. as a safe and effective technique.[24] They reported rapid improvement in the systemic response, with no complications. In our patient, a significant bilious leak from operatively placed drains prompted ERCP that demonstrated a large leak in either the medial or lateral segment of the left hepatic duct (Fig. 1 *B*). Stenting was successful in decreasing the biliary leak, but repeat ERCP was required for increased serum bilirubin, pain, and fever, suggestive of an occluded stent. Routine ERCP and stenting after laparoscopy has been proposed as an adjunct to management of bile ascites,[20]and stenting rather than sphincterotomy is felt to expedite healing of biliary leaks.[25] Finally, a repeat CT scan obtained for fever and an elevated white blood cell count revealed a biloma (Fig. 1 *C*) adjacent to the surgically placed biliary drain and required percutaneous drainage by interventional radiology. This patient underwent a total of four procedures during almost 3 weeks of hospitalization, typifying complex management of biliary complications.

Three patients required decompressive laparotomy for abdominal compartment syndrome. Of these, two patients had

significant hemoperitoneum as the cause. The third patient underwent laparotomy on PID 3 and was found to have bowel edema and ascites, and not hemoperitoneum, as the cause. Bowel edema and ascites are more frequently encountered with secondary ACS, prompting some to advocate percutaneous rather than open decompression. This technique has been reported as a therapeutic modality for burn patients with secondary abdominal compartment syndrome.[26,27] Its success in patients with primary ACS is likely to be limited, however, as the source of the compartment syndrome is typically ongoing bleeding rather than ascites or bowel edema.[28]

A multidisciplinary clinical pathway for the management of grade 4 and 5 injuries is presented in Figure 2. As grade 3 injuries have such a low incidence of complications, they have not been included. Patients with cleft injuries should undergo routine follow-up CT scanning at day 5 to 7 postinjury. Otherwise, patients can be followed clinically. Bleeding should be managed by IR angioembolization if the patient is hemodynamically stable or operatively if the patient is unstable. If peritonitis is diagnosed on clinical examination, immediate operative intervention is also warranted. For patients with unrelenting systemic inflammatory response syndrome or concerning abdominal findings, a repeat CT scan is recommended. If a hollow viscus injury is noted, immediate operation should be undertaken. In contrast, if significant bile ascites and/or hemoperitoneum is found, these can usually be successfully managed by laparoscopy and drainage. If a liver abscess or biloma is seen on CT, IR drainage is indicated. Persistent bilious drainage after laparoscopy or IR drainage should prompt ERCP and stenting. Finally, failure of percutaneous drainage techniques or biliary stenting may require operative intervention.

In summary, although patients with high-grade liver injuries can be safely managed nonoperatively, complications requiring a multidisciplinary treatment strategy should be anticipated in patients with grade 4 and particularly grade 5 injuries. If prediction models could be developed, screening for high-risk patients may result in earlier diagnosis and treatment of complex hepatic-related complications.

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